



Anthropogenic Causes of Ecosystem Degradation and Determinants of the Willingness of the Local Population to Participate in Collaborative Management of Bombo-Lumene Reserve

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Abstract

Protected areas play a critical role in biodiversity conservation in the Democratic Republic of Congo. However, they are under anthropogenic pressure. The study was carried out in the Bombo-Lumene reserve situated in Kinshasa, DR Congo. A questionnaire-based survey was conducted to determine the causes underlying ecosystem degradation and biodiversity loss and the determinants of the willingness of the population to participate in collaborative management with the State. Logistic regression was used to check the determinant factor. Findings showed that farming, charcoal production, and poaching are the direct causes of ecosystem degradation and biodiversity loss. The indirect cause is land confiscation, which causes conflicts between the local population and the State. Consequently, the majority of the respondents are not willing to participate in collaborative management. Results of logistic regression indicated that level of education was the only explanatory factor that determines the willingness to participate in collaborative management with the State.

Subject Areas

Conservation Biology, Environmental Sciences

Keywords

Protected Area, Anthropogenic Causes, Collaborative Management, Bombo-Lumene

1. Introduction

Protected areas (PA), which represent the cornerstone of conservation efforts [1] [2], currently cover 15.4% of the world's terrestrial surface which is an area larger than the African continent [3]. Notwithstanding, PAs are worldwide subjected to growing anthropogenic pressures either directly or indirectly [3] [4] [5] [6]. In the Democratic Republic of Congo (DRC), those pressures are mainly a consequence of the indirect causes such as poverty, slow and weak economic growth, high population growth, armed conflict, corruption, poor law enforcement and poor PAs management, and ignorance by the local communities of the importance of conservation [4] [7]. Degradation of ecosystems, as a result of anthropogenic activities, has been particularly observed in Bombo-Lumene game reserve (BL) as the majority of people living within and around depend exclusively on the forest for their livelihood [7] [8] [9] [10]. Unfortunately, apart from observed juridical and institutional shortcomings, studies on the mode of exploitation of natural resources in this area are either old, fragmentary, non-published, or sometimes non-existent [4]. That is the reason this study sought to understand the local population's perception of the main causes underlying ecosystems degradation and biodiversity loss, and the willingness of people to participate in collaborative management (CM) with ICCN (Congolesse Institute for Nature Conservation). Collaborative management of protected areas is defined as "a partnership by which various stakeholders agree on sharing among themselves the management functions, rights, and responsibilities for a set of resources" [11].

2. Materials and Methods

2.1. Study Area

Bombo-Lumene game reserve is located between 4°43'53" South latitude and 16°02'09" East longitude in the commune of Maluku, about 130 km east of the center of the city of Kinshasa (**Figure 1**). It covers an area of 350,000 ha and is bordered in the north by the National Road No. 1, in the south by Kasangulu territory in Bas-Congo province, in the east by river Lufimi, in the West by river Bombo. According to Koppën classification, the climate is of type AW4, characterized by a rainfall elevated 1500 mm with 8 months of the rainy season and 4 months of the dry season. The average temperature varies from 25°C to 26°C between March and April and 19°C from July to August. The altitude of the site ranges between 650 and 700 meters.

2.2. Methods

2.2.1. Data Collection

Primary data was collected through a questionnaire-based survey. The questionnaire was administrated to 400 heads of households in the following 6 villages, in addition to the BL station: Bu, Mpoki-N'sele, Dumi-Mutiene, Buantaba, Limbimi, and Mbankana. The observation was also employed as an interesting

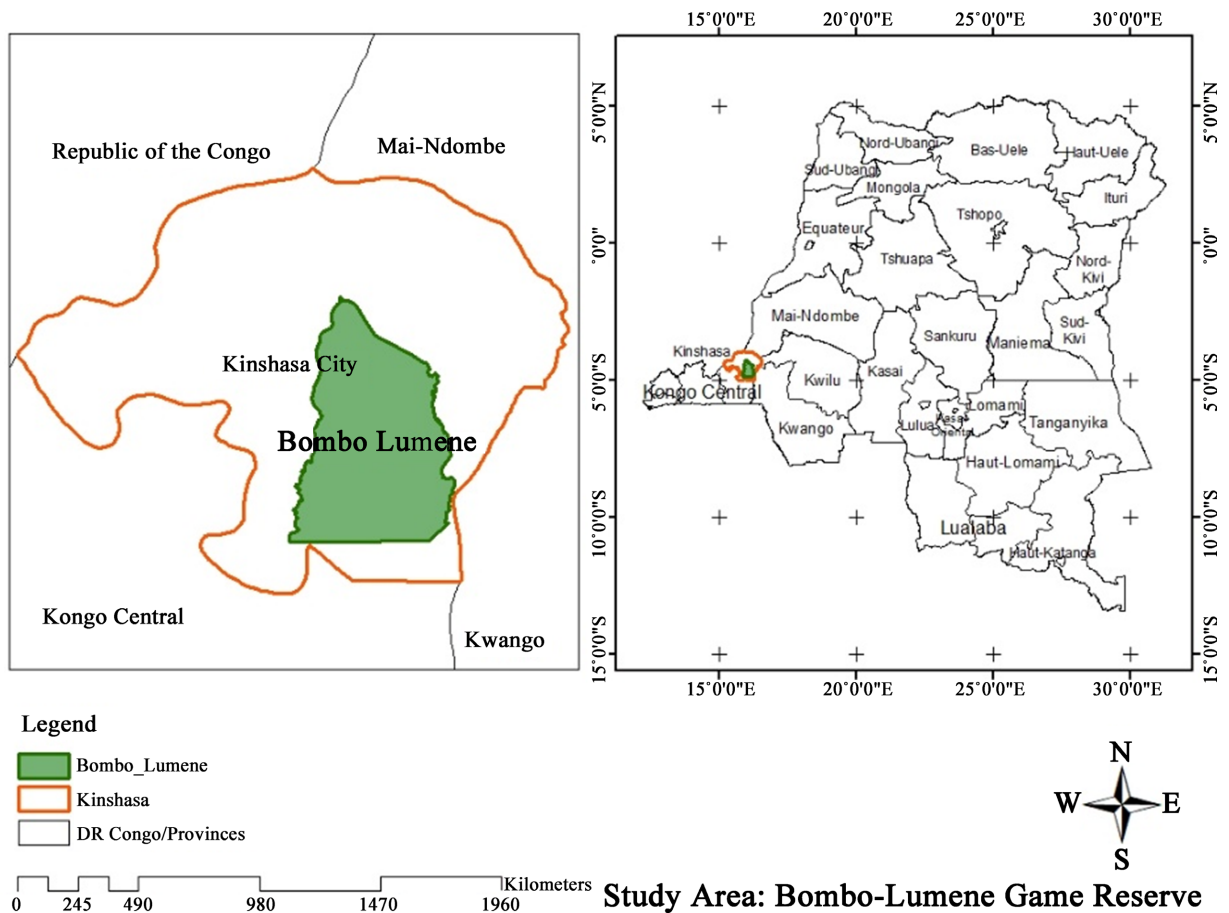


Figure 1. Map of Bombo-Lumene Game Reserve.

approach in this study. Data was collected in 2014 and updated in 2021.

2.2.2. Analysis

The database was created in Excel and statistical analysis including descriptive and inferential analyzes was done using Statistical Package for Social Sciences (SPSS). The descriptive analysis presented frequency distribution and percentages. Then logistic regression (Equations (1) and (2)), was used as a statistical test as the dependent variable is qualitative and binary [12] [13] [14]. The significance level (α) used is 0.05. Results are derived from the p-value and the coefficients. A positive coefficient indicates that when one variable increases, the other one also increases [15].

$$\text{Logit}(Y) = \text{natural log (odds)} = \ln\left(\frac{\pi}{1-\pi}\right) = \alpha + \beta X \tag{1}$$

Taking the antilog of Equation (1) on both sides, one derives an equation to predict the probability of the occurrence of the outcome of interest as follows:

$$\begin{aligned} \pi &= \text{Probability}(Y = \text{outcome of interest} \mid X = x, \text{ a specific value of } X) \\ &= \frac{e^{\alpha+\beta x}}{1+e^{\alpha+\beta x}} \end{aligned} \tag{2}$$

where π is the probability of the outcome of interest; α is the Y intercept; β is the

regression coefficient; e is the base of the system of natural logarithms. X can be categorical or continuous, but Y is always categorical.

3. Results and Discussion

The results show that 72% of surveyed people were male and 28% were female. The majority (36%) were within the age range of 30 to 39, followed by those within the range of 40 to 49 (32%), then those who were at least 50 years old (26.7%) and those under 29 years (5.3%). The majority (61.3%) of respondents had the secondary school education level, while 22.7% had the primary level and 16% had a university degree. Most (61.3%) of interviewees acknowledged farming as their main occupation, some were involved in trading (9.3%), charcoal production (6.7%), others work in private (17.3%) and public (5.3%) sectors. Most (49.9%) of respondents have been living in the area for at least 31 years, only 9.3% have been living there for less than 10 years.

3.1. Causes of Ecosystem Degradation and Biodiversity Loss

When asked about the current state of natural resources in the reserve, the majority (81.3%) of respondents declared that natural resources of BL are degraded; 68% disclosed that this degradation goes back to around three decades. Land confiscation is the indirect cause underlying natural resource degradation in BL. The population gets angry after the confiscation of their lands by the State in the name of conservation. As consequence, they sabotage biodiversity and the resources of the reserve. Consequently, this situation brings conflicts between the local population and the State [16], and resource-based conflicts may be extremely destructive and undermine conservation [17].

3.1.1. Direct Causes

The direct causes are agriculture (47.4%) and charcoal production (40.6%). Poaching was also pointed out, by all the respondents, as a direct cause of the drastic reduction of animal species. The animals are doubly affected by those activities because apart from poaching, their natural habitat is destroyed by agriculture and charcoal production. Instinctively, they migrate in order to find a better place, but they end up exposing themselves to fiercer poaching outside the reserve. WWF [18] reported that hunting and poaching practices have depleted the fauna of BL, drastically depleting buffaloes and antelopes and completely exterminating populations of elephants and lions. Illegal entries of surrounding people into the reserve for charcoal production are a sad reality.

Most PAs worldwide are under threat from encroachment or poaching as a consequence of conflict between the conservation of important sites and the basic needs of the local populations that are traditionally dependent on the resources of those areas [19]. Collins *et al.* [19] continued arguing that in many tropical countries where the population continues increasing, the level of conflict is intensified and will continue in the next decades.

3.1.2. Pressure from Agriculture

Among people whose livelihood is farming, most (79.3%) of them have their farms within the reserve, while 20.7% cultivate outside the reserve's boundaries. Shifting cultivation was found as the main agricultural system accounted for 53.8% of practitioners, 27.7% were involved in extensive mechanized agriculture and 18.5% were engaged in market gardening. Farms' size ranged from 1 to 10 hectares; however, the average farm size per farmer is 2.3 ± 1.4 ha.

Cassava, sweet potato, corn, and cowpeas are the most cultivated species among food crops produced by the local population. Eggplant, tomato, pepper, amaranth, and nightshade are the most prevalent among the vegetables. The most produced fruit trees are avocado, mango, lemon, orange, tangerine, and butter fruit.

This is a terrible situation confirmed by [20] and [21] who reported that the population that lives inside and near protected areas and uses the land, plants, and animals to meet their basic livelihood needs. Then, depending on the type of management practice, these populations will have different impacts on natural resources, which can increase or decrease pressure on land and biodiversity within and around a protected area [20].

3.2. The Management

The results indicate that 80% of respondents were aware that the BL is managed by the ICCN (Congolese Institute for Nature Conservation) while 20% were not. Only 33.7% of respondents declared being associated with the management of natural resources of BL by sensitizing local communities to get involved in the conservation of natural resources of the reserve. They declared that some efforts have been made to inform the community about collaborative management particularly through radio programs and workshops. Yet, the majority of the respondents do not want to get involved in collaborative management. According to them, from their previous experience, ICCN used to impose what to do and what not to do within the reserve without caring about the population's livelihood and beliefs. Seeland [22] confirmed that in PAs, farmers' daily life is threatened either by regulations and some inappropriate measures to help the local population overcome the deficiencies of nature conservation administration. This shows that the implementation of PAs for biodiversity conservation may have both positive and adverse impacts on the local population [23].

Collaborative management (CM) was implemented by ICCN for the sustainable management of natural resources in PAs in DRC [7] but seemingly up to date, it is not yet effective in all the PAs of the country. This is confirmed by a study conducted by [3] on models for CM of PAs, does not list BL as a PA whereby CM works. Since CM is an interactive approach of all stakeholders and the primary stakeholders include the institution—ICCN in this case—and local communities [11], there is a need for ICCN to effectively include the local population in BL. Their role in the management must be clearly defined, the mode and right of access to natural resources must be specified and conflicts between

public administration and the local population must be identified, analyzed, and addressed [24]. In doing so, this collaboration between local communities and ICCN will be accepted by the population and this will be a step forward in mitigating anthropogenic pressures in BL. This difficulty or misunderstanding between local communities and public administration is not peculiar to BL. FAO [25] and Ward *et al.* [23] reported that in several countries, the effective application of a participatory approach, despite the wishes displayed and the many efforts made so far, is still a major challenge.

Despite the reluctance of some, the key components are information and communication. It is imperative to implement a communication strategy through which information must circulate most simply and understandably, explaining the merits, fundamentals, and expected results of the CM approach. This may be achieved by sharing information—through conventional media, documentaries, magazines, etc.—on the importance and challenges of the RN, identifying strengths, weaknesses, threats, opportunities, and suggesting adequate mitigation measures against human pressures.

3.3. Results of Logistic Regression

The results of the logistic regression analysis (**Table 1**) indicate that the variable *education level* is significant ($p = 0.000$) at $\alpha = 0.01$. Its positive coefficient (8.034128) indicates that the level of education increases the probability that an individual accepts CM between the local population and ICCN in the management of BL.

Education opens the mind to more integrated and systemic thinking. That is to say, a community made up of educated individuals will be more likely to understand the importance of CM with other stakeholders. This is in agreement with [26] who reported that the positive behavior of the local population towards conservation of natural resources in Pendjari National Park was highly correlated with the education level of participants.

4. Conclusion

The study focused on causes driving degradation and biodiversity loss in the process of conserving natural resources in protected areas. People living within and around BL regard the land as a property as long as they traditionally own and occupy it, and use it for their diverse livelihood and other activities. This perception of local communities is disturbed because of the expropriation of land for public utility, which causes frustration among local communities. This is the major source of conflict between the state and local population and that

Table 1. Logistic regression between the variable willingness of local population participation in CM and level of education.

Variable	Coefficient	Standard error	Degree of freedom	p-Value
Education level	8.034128	0.8591386	1	0.000

pushes them to carry out unrecommended activities within the BL reserve. Direct causes driving ecosystem degradation and biodiversity loss are agriculture, charcoal production, and poaching. The local population is supposed to be a key component in the management of the reserve but it is not yet the case. Involving them will be an effective mitigation measure of anthropogenic pressures; therefore, it is a way to improve biodiversity conservation and ecosystem restoration in the reserve. The determinant of the willingness for an individual to accept collaborative management was the level of education.

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Conflicts of Interest

The authors declare no conflicts of interest.

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